THEORY OF COMPUTATION
AUTOMATA- 1

SOLUTIONS

1.

$r_1 = 1\ (0 + 1)^*$
$r_2 = 1\ (1 + 0)^+$
$r_3 = 11^*0$

Which of the following is true?

(a) $L(r_1) \subseteq L(r_2)$ and $L(r1) \subseteq L(r_3)$
(b) $L(r_1) \supseteq L(r_2)$ and $L(r_2) \supseteq L(r_3)$
(c) $L(r_1) \supseteq L(r_2)$ and $L(r_2) \subseteq L(r_3)$
(d) $L(r_1) \subseteq L(r_3)$ and $L(r_2) \subseteq L(r_1)$

Solution: Option (b)

2. Give the strongest correct statement about finite language over finite Σ ?

(a) It could be undecidable
(b) It is Turing-recognizable
(c) It is CSL
(d) It is regular language

Solution: Option (d)

3. Let n_1 and n_2 be the number of states in NFA and minimal DFA of a regular language. Then,

(a) $n_1 \geq n_2$
(b) $n_1 \leq n_2$
(c) $n_1 < n_2$
(d) $n_2 > n_1$

Solution: Option (b)

4.

S_1: L is regular. Infinite union of L will also be regular i.e. $(L^0 \cup L^1 \cup L^2 \ldots)$
S_2: L is regular. It's subset will also be regular.

(a) Both are true
(b) Both are false
(c) $S_1 \rightarrow T$, $S_2 \rightarrow F$
(d) $S_1 \rightarrow F$, $S_2 \rightarrow T$

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Solution: Option (b)

Explanation:

For Statement 1:
Regular languages are closed under finite union. They are not closed under infinite union of regular languages.

Consider

$L_1 = \{01\}$
$L_2 = \{0^2 1^2\}$
$L_3 = \{0^3 1^3\}$
.
.
.
So, infinite union of $L_1 \cup L_2 \cup L_3 \cup \ldots = \{(0^n 1^n)/(n > 0)\}$ is CFL but not regular.

For Statement 2:
Subset of regular language may not be regular.

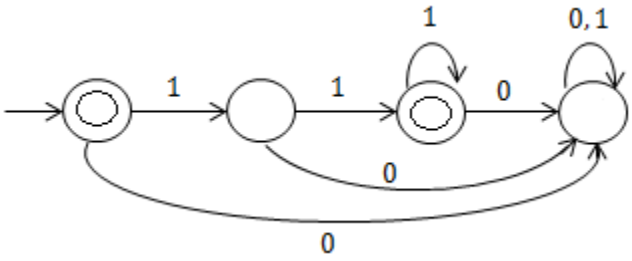
Consider $L = 0^* 1^*$ and $L_1 = \{0^n\ 1^n / n > 0\}$. L_1 is a subset of L but not regular.

5. Consider r = (11 + 111)* over Σ = {0, 1}. Number of states in minimal NFA and DFA respectively:

(a) N – 3, D – 4
(b) N – 3, D – 3
(c) N – 3, D – 3
(d) N – 4, D – 4

Solution: Option (a)

Explanation:
The language for the given regular expression is $L = \{\varepsilon, 11, 111, 1111, 11111, \ldots\}$. So the DFA is



For NFA, remove the dead state and corresponding incoming and outgoing edges. .

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6. A Language is said to be regular iff

(a) There exists a Right Linear Regular Grammar for L
(b) There exists a Left Linear Regular Grammar for L
(c) There exists a nfa with a single final state
(d) There exists a dfa with a single final state
(e) There exists a nfa without ε - move.

Which are true?

(i) All are true
(b) a, b, c are true
(c) a, b, c, e are true
(d) a, b, d are true

Solution: Option (iii)

Explanation:
As a DFA with multiple final states, cannot be converted to DFA with single final state.

7. Consider 2 scenarios:

C_1: For DFA (ϕ, Σ, δ, q_o, F),
if F = ϕ, then L = Σ^*

C_2: For NFA (ϕ, Σ, δ, q_o, F),
if F = ϕ, then L = Σ^*

Where F = Final states set
ϕ = Total states set

(a) Both are true
(b) Both are False
(c) C_1 is true, C_2 is false
(d) C_1 is false, C_2 is true

Solution: Option (c)

Explanation:
As in case of NFA even is F = ϕ, dead state rejection is there so $L \neq \Sigma^*$.

8. Consider this FA:

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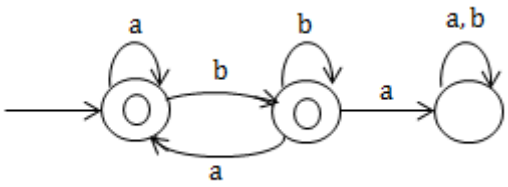

How many strings will be there in the complement of the language accepted by this Finite Automata?

(a) Infinite
(b) 2
(c) 3
(d) 0

Solution: Option (d)

Explanation:
As L is $(a + b)^*$
$\overline{L} = \{\ \}$

9. In Programming language, an identifier has to be a letter followed by any number of letters or digits. If L and D denotes the sets of letter and digits respectively, examine the correct expressions?

(a) $(L \cup D)^*$
(b) $(L \cdot D)^*$
(c) $L \cdot (L \cup D)^*$
(d) $L \cdot (L \cdot D)^*$

Solution: Option (c)

10. Total number of DFA possible with 2 states $q_0 \rightarrow$ start and non-final, $q_1 \rightarrow$ final over $\Sigma = \{a,b\}$ is

(a) 16
(b) 32
(c) 48
(d) 64

Solution: Option (a)

Explanation:

16 DFA's are possible.

	0	1
$\rightarrow q_0$	2	2

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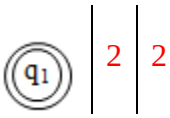

Total = 2 × 2 × 2 × 2 = 16

11.

$\Sigma = \{0, 1\}$
$L = \Sigma^*$
$R = \{ O^n 1^n$ such that $n > 1\}$

Languages L ∪ R and R are respectively:

(a) Regular, Regular
(b) Regular, Not Regular
(c) Not Regular, Not Regular
(d) Not Regular, Regular

Solution: Option (b)

Explanation:
L ∪ R → Regular
R → CFL

12.

$L_1 = \{ a^m \mid m \geq 0\}$
$L_2 = \{ b^m \mid m \geq 0\}$

$L_1 \cdot L_2 = ?$

(a) $\{ a^m b^m, m \geq 0\}$
(b) $\{a^m b^n, m, n \geq 0\}$
(c) $\{a^m b^n, m, n \geq 1\}$
(d) None of the above

Solution: Option (b)

13. Consider these statements:

S_1: If a language is infinite, it has to be non-Regular.
S_2: Let L be any language.

$(\overline{L})^* \neq (\overline{L^*})$

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(a) Both are True
(b) Both are False
(c) $S_1 \rightarrow$ True, $S_2 \rightarrow$ False
(d) $S_1 \rightarrow$ False, $S_2 \rightarrow$ True

Solution: Option (d)

Explanation:
Infinite can also be regular $\rightarrow a^*$
$(\overline{L})^*$ will surely contain $\in$
but $(\overline{L^*})$ will not contain $\in$.
So, they are not equal.

14. Which of the following R.E. over $\Sigma = \{0, 1\}$ denotes set of all strings not containing as sub-string.

(a) $0^* (0 + 1)^*$
(b) $0^* 1 0 1 0^*$
(c) $0^* 1^* 0 1$
(d) $0^* (1 0 + 1)^*$

Solution: Option (d)

15. Which of the following set can be recognized by DFA?

(a) Numbers 1, 2, 4, 8, . . . 2^n written in binary
(b) Numbers 1, 3, 4, 8, . . . 2^n written in unary
(c) Set of binary strings in which number of zeroes is same as number of 1's
(d) Set {1, 101, 11011, 1110111, . . .}

Solution: Option (a)

Explanation:
L = 1 0*

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